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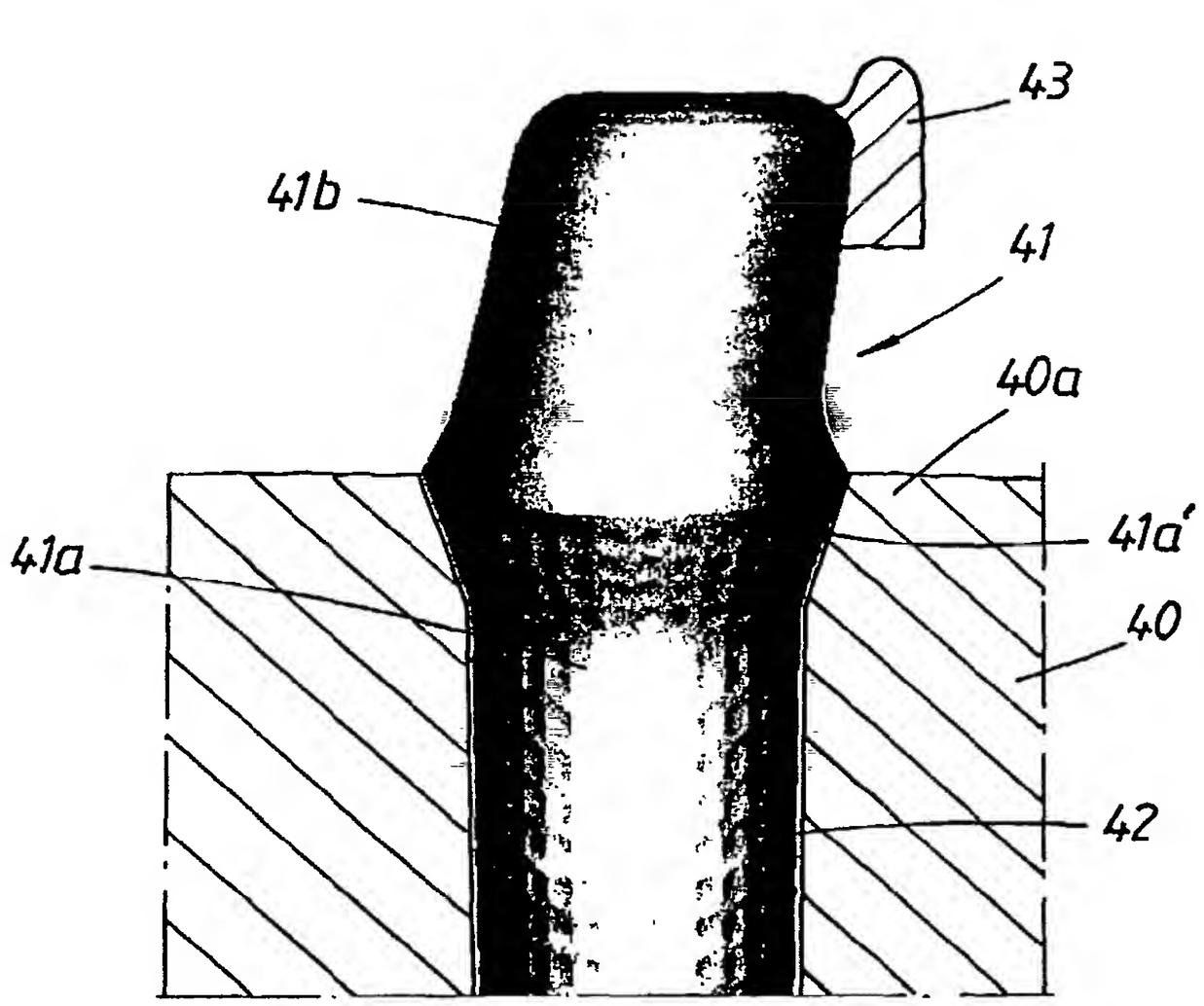
(54) Title: METHOD FOR PRODUCING A SURFACE STRUCTURE ON THE SURFACE OF AN IMPLANT, AND SUCH AN IMPLANT




(57) Abstract: A surface structure is produced on an implant surface by means of cutting work in which parts of a tool are pressed, during surface production, against the implant or against a blank which is intended to form the implant. The parts and the implant/blank are assigned controls which give rise to mutual displacements between the parts and the implant/blank in order to form the surface structure. The controls are initiated by means of first apparatus for identification of the implant situation and production of parameters for bone types and implant types. The controls are transmitted to second apparatus controlling the tool which are designed to work with a suitable movement function, for example oscillator function, roller function, etc., by means of which said parts cooperate with the implant/blank and are caused to execute the movements. The controls are chosen so as to produce cup-shaped depressions arranged alongside one another and separated by intermediate ridges. The invention also relates to an implant with such depressions.

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Method for producing a surface structure on the surface of an implant, and such an implant.

The present invention relates, inter alia, to a method for producing a surface structure on a surface, preferably an outer surface, of an implant or fixture by means of cutting work in which parts of a tool are pressed or applied, during surface production, against the implant or against a blank which is intended to form the implant. The parts and/or the implant or blank are assigned controls which give rise to mutual displacements between the parts and the implant or blank such that the surface structure is formed. The controls are initiated by means of first apparatus for identification of the implant situation and production of parameters for bone types and/or implant types. The controls are intended for second apparatus controlling the tool.

The invention also relates to an implant or a fixture which has a surface, preferably an outer surface, based on the cooperation with parts of a tool, for example a milling tool, which are able to be pressed against the surface. The outer surface is designed to take part in or execute a movement function with the parts so as to permit, depending on the controls, mutual displacements in relation to the parts in order to form a surface structure.

The invention can be applied inter alia to dental situations and the implant or the fixture is preferably made of titanium, although other tissue-compatible material can also be used. In connection with the method, the parts can in principle be stationary and the implant movable, for example displaceable and/or rotatable in relation to the parts. Alternatively, the parts in question can execute the movements in relation to the stationary implant or fixture. In the third

embodiment, the parts and the implant together move in the mutual movements.

The present invention is based on one or more outer surfaces of an implant being provided with an arrangement which includes a surface pattern which has been produced by cutting work, for example milling or shot-peening. Reference may be made in this connection to the prior art and in quite general terms to the patent literature which specifies a large number of surface patterns on cylindrical, cone-shaped and/or threaded outer surfaces of implants, for the jaw bone for example.

The pattern or surface structure created on the implant or fixture is in principle to be applied to bone or tissue in the human body, and the object of the surface structure is to obtain a stimulated and effective incorporation of the implant in the bone or soft tissue.

Production of microfabricated outer surfaces on implants has been discussed in SE 511863 (from the same Applicant as the present application), US 5,588,838, EP 720454 and EP 475358.

In connection with the fitting of implants, there is a considerable requirement to be able to achieve optimum and high-quality implant results. There is a need to have access to a large number of parameters which can be exploited in different patients and different implantation situations. Given the demands of patients and treatment personnel, not all parameters can be applied in different cases. The bone quality, the attitude of the patients, costs, etc., can be limiting factors, and even if development work and proposals permitting good results are moving in one direction, there may be a need for alternative solutions to be offered or used in different individual cases. The

present invention aims, inter alia, to solve this problem and proposes a novel solution for optimum and effective implant fittings.

The present invention is based on the idea of achieving effective incorporation of an implant in the particular bone, for example the jaw bone, with the aid of a unique surface structure, thereby achieving substantial stability of the implant incorporation in the bone in a short time, for example after just 1 to 5 days. The invention solves this problem too. In one embodiment, it is important to prevent or counteract bacterial growth at the parts where the implant emerges from the bone, for example the jaw bone. There is also a need to be able to obtain said surface pattern in a technically economical way. The invention solves this problem too.

The feature which can principally be regarded as characterizing a method according to the invention is, inter alia, that the second apparatus are designed to work with a movement function, for example an oscillator function or roller function, by means of which said parts, in their cooperation with the implant or blank, are caused to execute the movements in question, and that the controls are chosen or adapted so as to produce cup-shaped depressions which are arranged in a pattern alongside one another and are separated by intermediate ridges.

In one embodiment of the method, at least some of the depressions have a substantially spherical-cap shape. Alternatively, or in addition, some of the depressions can have elliptical or oval shapes at their upper areas merging into the ridges.

The feature which can principally be regarded as characterizing an implant or a fixture according to the invention is, inter alia, that the surface comprises cup-shaped depressions which are formed by means of the

movements in the movement function and which are arranged in a pattern for the surface structure alongside one another and separated by intermediate ridges.

Embodiments of the novel implant are set out in attached dependent patent claims for the implant or fixture.

By means of what has been proposed above, effective incorporation of the implant or the fixture in the bone in question is achieved. The pattern or the surface structure can be varied so that the depressions are designed with different surface areas and depths. The depressions and the depths can be varied along the circumference and/or length of the implant. By means of the proposed surface structure, the latter has a formation comparable to the surface structure on a golf ball for example. The method and the implant can be included in an ordering and production system of a type known per se, for example a PROCERA® system.

A presently proposed embodiment of a method and an implant according to the invention will be described below with reference to the attached drawings, in which

Figure 1 shows a diagrammatic representation of a system for identification of implantation situations, for example in dental contexts, and ordering and production functions for an implant with the surface structure in question,

Figure 2 shows, in horizontal views, different shapes of surface structures in the pattern,

Figure 3 shows a side view of parts of an implant arranged in a jaw bone,

Figure 4 shows in a side view, and on an enlarged scale, parts of the implant according to Figure 3,

Figure 5 shows, further enlarged in relation to Figure 4, parts of the implant according to Figure 4, and

Figure 6 shows, in block diagram form, an arrangement for producing the surface structure.

In Figure 1, a jaw bone of a patient is shown by 1. A number of teeth have been shown symbolically, and one tooth is indicated by 2. In connection with the treated patient (or vice versa), an apparatus 3 is used for identification, analysis and/or virtual constructions of all or some of the teeth which are to be repaired or replaced by a prosthetic construction. The apparatus 3 can include or consist of computer equipment 4 with associated terminal 5. Identification members can also be included for identifying the situation in question. Such an identification member can include model production, imaging, etc. The member in question is indicated by 6 in Figure 1. As said apparatus 3 is known per se, it will not be described in detail here. Communications and interactions with the patient in question and the treating personnel (dentist, surgeon, etc.) have been symbolized by interaction arrows 7, 8 and 9. The result of identification, analysis, etc., results in control functions or controls which have been symbolized by 10 and communication arrows 11, 12 and 13 which can consist of digital signals transmitted by wire or wirelessly, for example via the telecommunications and/or computer network. The digital controls in the communication 10 have been indicated by i1.

The result from identification, analysis, etc., is transmitted as order information via the communication

arrangement 10 to a central unit which has been indicated by 14. Compare the PROCERA® system which is known per se. The central unit 14 can, in a manner known per se, initiate orders of components which are required in connection with identification, analysis, etc. Depending on signals or files i1, the central unit 14 can cooperate with or comprise a production station 15 for components which are identified and/or analyzed and constructed in the function 3. The communications between the central unit 14 and the production control unit 15 have been symbolized by 16, in which communication a number of two-way communication functions are included, one having been indicated by 17. The station or the unit 15 comprises or uses a machine assembly 18 which can be included in machinery for production of different components. The machine assembly 18 comprises a control unit 19 which can be controlled from the station 15 by means of communications 20 which have been indicated by two-way arrows, of which one two-way arrow has been labeled 21. A machine 22, for example of the CAD/CAN type, can be included in the machine assembly and is controllable from the control unit 19 in a manner known per se. An implant or a blank for an implant has been shown in part by 23. The implant or the blank has an outer surface 24 which is to be provided with an outer structure 25. Parts of the machine 22 which are able to cooperate with the outer surface of the implant or of the blank have been shown by 26. The parts in question can move vertically in the directions of the arrows 27 and also parallel to the longitudinal axis 28 of the implant in the directions of the arrows 29. The implant can be rotated about its longitudinal axis 28, see the rotation arrow 30. The implant is clamped securely in a rotating device 31 which is controlled by the unit 19. The implant can also be moved lengthwise in the directions of the arrows 32 along its longitudinal axis. It is therefore possible to obtain different

mutual displacement patterns between the parts 26 and the implant 23, see above.

Controls or control signals can thus be established between the above-described apparatus. Thus, control signals between the units 14 and 15 have been indicated by i2, control signals between the units 15 and 19 have been indicated by i3, control signals between the control unit 19 and the machine 22 have been indicated by i4, and control signals between the control unit 19 and the unit 3 have been indicated by i5. With the system according to Figure 1, the patient's dental function can thus be scanned and identified with the aid of scanning equipment, models, etc. The situation can be treated virtually in the apparatus 3, and the evaluation or equivalent can be based on emprirical data, for example with the aid of a library 3a in which typical or earlier implant situations have been stored. The order can be transferred by media, and the central unit can receive the orders i2 and in turn control the surface structure production 25 by means of controls i3, i4 and i5.

The surface structure 25 indicated in Figure 1 can be designed with different shapes and depths of depressions. A characteristic of the machine 22 is that the parts 26 and the blank 23 execute mutual movements, for example oscillation movements, rolling movements, etc. In one embodiment, the parts 26 execute the movement, which thus means that the movements 27 consist for example of oscillation movements or roller movements. Alternatively, the blank can execute said movements. In a further alternative, the parts 26 and the implant or blank together execute the movements. The depressions 25a, 25b etc. in the pattern 25 can be designed with different horizontal sections. Likewise, the depth D of the depressions can be varied, but this is preferably chosen in the range of 25-250 µm. The control unit 19 or the machine 22a can be provided with

programs which in Figure 1 are symbolized by 19a and 22a. These programs are arranged to effect the movement function of the parts 26 and/or the implant 23. The program can be of a type known per se and can work with an algorithm of likewise known type.

Figure 2 shows different types of depressions. The depressions can have an external dimension, for example a diameter D' of the order of 100-300 µm. Thus, the depressions can have a substantial spherical-cap shape 33, the shape of a truncated ellipse 34 or 35, or combinations 36 of said shapes 33, 34, 35, etc. In Figure 1, the depressions 25a, 25b are shown separating ridges 37, 38 and 39, into which the depressions merge.

In Figure 3, parts of a jaw bone are shown by 40. Parts of an implant 41 are arranged in a recess 42 in the jaw bone. The recess can be formed in a manner known per se and this will not be described in detail here. The implant is embedded in the recess 42 via its parts 41a and the surface structure 41a is designed in accordance with what has been described above with reference to Figure 1. The depressions and the ridges can be arranged with substantially the same sizes and depths along the height of the implant. Alternatively, the depressions and the ridges can vary in shape along the length and/or the circumference of the implant. Thus, for example, a part 41a' which can cooperate with the dentine 40a, and which is cone-shaped in the example shown, can be designed with first depressions and ridges, while the part 41a extending in the jaw bone 40 can be arranged with depressions and ridges of other sizes. The part 41b projecting above the dentine 40a is intended for cooperation with a prosthetic construction which is symbolized by 43. The part 41b can be designed with further sizes of depressions and/or ridges or can have no depressions or ridges at all.

Figures 4 and 5 show the formations of the depressions in more detail. Figure 4 shows different depressions 44 and 45 on the part 41a. At its portion merging into the part 41a', the part 41a has doubled depressions 45a and 45b which are separated by a small ridge 45c. The part 41a' has another type of depressions 46, and the area 47 of the part 41b' has no depressions or ridges. Ridges which separate the depressions 46 are indicated by 48 and 49 in Figure 5.

According to Figure 6, the production of the surface structure can be object-oriented, in which information concerning the surface structure, i.e. thread(s), lengths, surface structure formation, etc., can be collated and introduced into fields 50, 51 according to a structure taken from ASCI, IGES, STL, etc. A value function 52 can be included such as a CPU (computer unit) 53, which operates with a known program 54. An algorithm used in this connection for the surface structure formation is indicated symbolically by arrows 55. The surface structure pattern 56 is produced in the arrangement which supplies milling coordinates 57 for the unit 58 for implant production, see above. Cooperation functions between CPU and 56, 58 may also be present and have been indicated by arrows 59 and 60, respectively.

The invention is not limited to the embodiment described above by way of example, and instead it can be modified within the scope of the attached patent claims and the inventive concept.

Patent Claims

1. A method in which a surface structure is produced on a surface, preferably an outer surface, of an implant (fixture) by means of cutting work in which parts of a tool are pressed, during surface production, against the implant or against a blank which is intended to form the implant, and at the same time the parts and/or the implant or blank are assigned controls (14) which give rise to mutual displacements between the parts and the implant or blank in order to form the surface structure, the controls being initiated by means of first apparatus for identification of the implant situation and production of parameters for bone types and/or implant types and being transmitted to second apparatus controlling the tool, characterized in that the second apparatus are designed to work with a function by means of which said parts, in cooperation with the implant or blank, are caused to execute movements, and in that the controls are chosen or adapted so as to produce cup-shaped depressions which are arranged alongside one another in a pattern and are separated by intermediate ridges.

2. The method as claimed in patent claim 1, characterized in that at least some of the depressions have a substantially spherical-cap shape.

3. The method as claimed in patent claim 1 or 2, characterized in that at least some of the depressions have elliptical or oval shapes, or combinations thereof, at their upper areas merging into the ridges.

4. An implant (fixture) which has a surface, preferably an outer surface, based on the

cooperation with parts of a tool, for example a milling tool, which are able to be pressed against the surface, and are designed to take part in or execute a movement function with the parts so as to permit, depending on the controls, mutual displacements in relation to the parts in order to form a surface structure, characterized in that the surface comprises cup-shaped depressions which are formed by means of the movements in the movement function and which are arranged in a pattern for the surface structure alongside one another and separated by intermediate ridges.

5. The implant as claimed in patent claim 4, characterized in that at least some of the depressions have spherical-cap shapes.

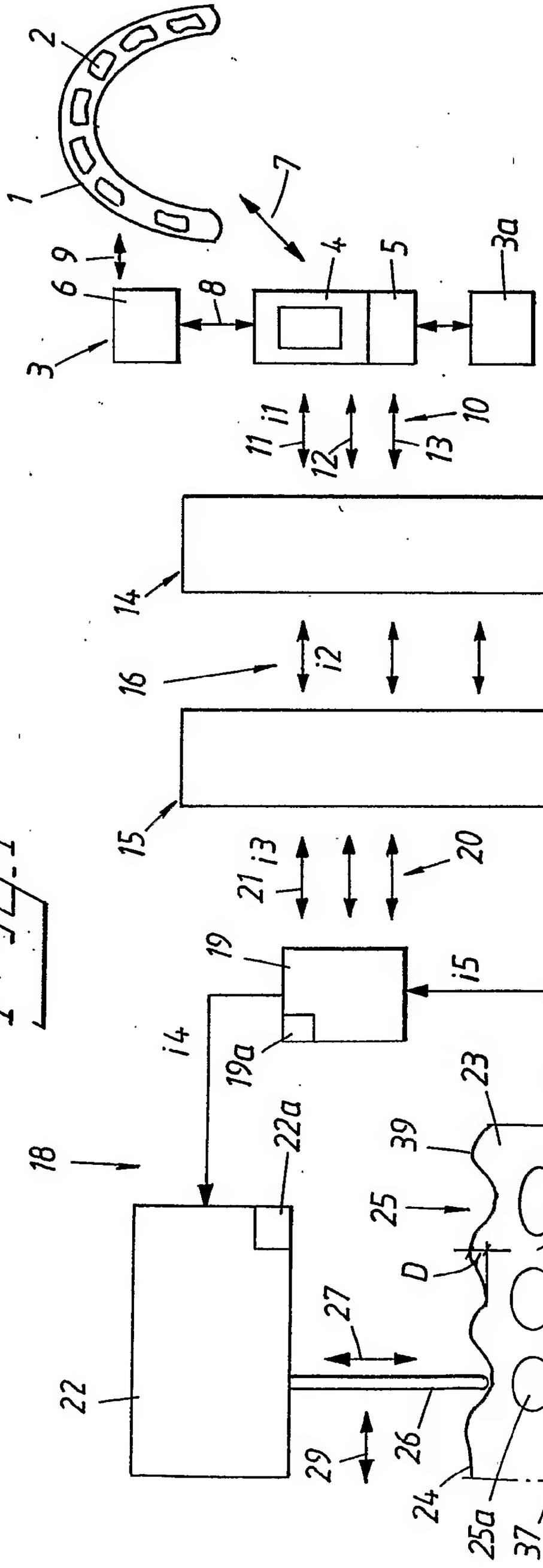
6. The implant as claimed in patent claim 4 or 5, characterized in that at least some of the depressions are arranged with elliptical or oval shapes, or combinations thereof, at their upper areas merging into the ridges.

7. The implant as claimed in any of patent claims 4, 5 or 6, characterized in that said pattern is based on an algorithm controlling the second apparatus.

8. The implant as claimed in any of patent claims 4-7, characterized in that the movement function consists of an oscillator function or roller function.

9. The implant as claimed in any of patent claims 4-8, characterized in that the shapes of the pattern and of the depressions are based on controls dependent on analysis and/or virtual adaptation functions effected by means of computer device(s) (4, 5) included in the first apparatus.

10. The implant as claimed in any of patent claims 4-9, characterized in that the shapes of the pattern and of the depressions are based on experiences of earlier implant fittings, which experiences can form part of or be included in a library function (3a) from which they are accessible by means of the first apparatus.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25a
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Fig. 1

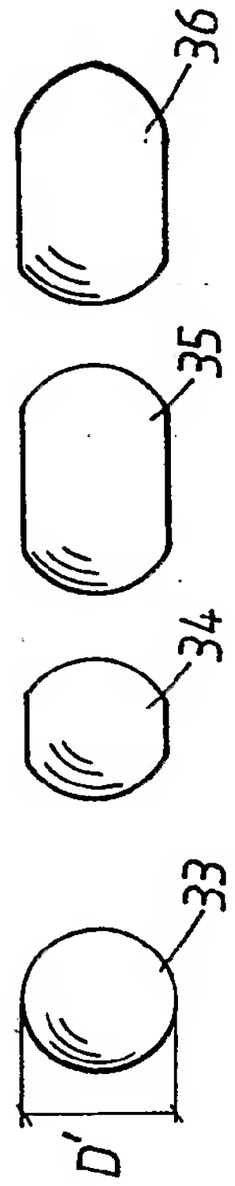
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Fig. 2

Fig 3

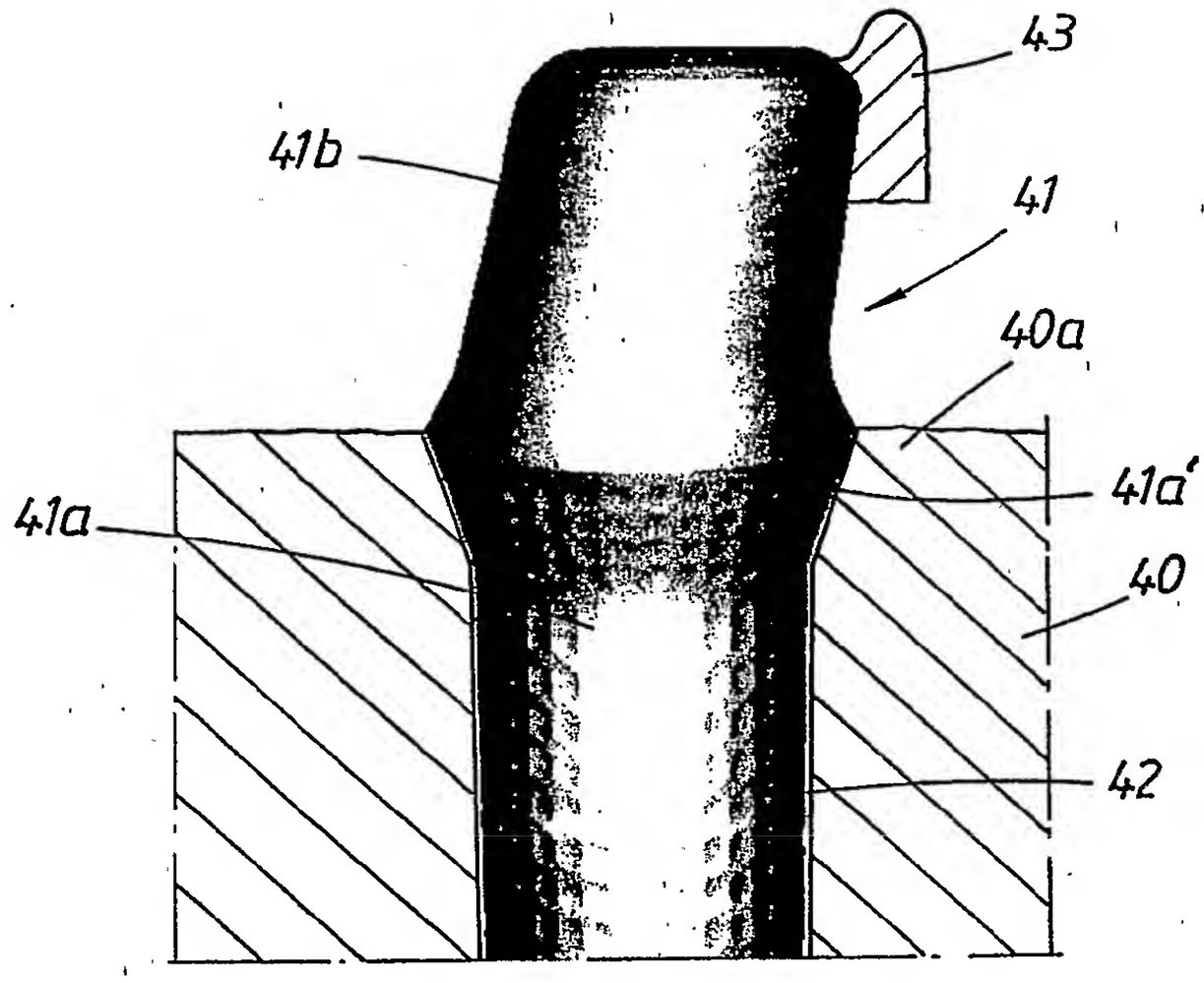



Fig 4

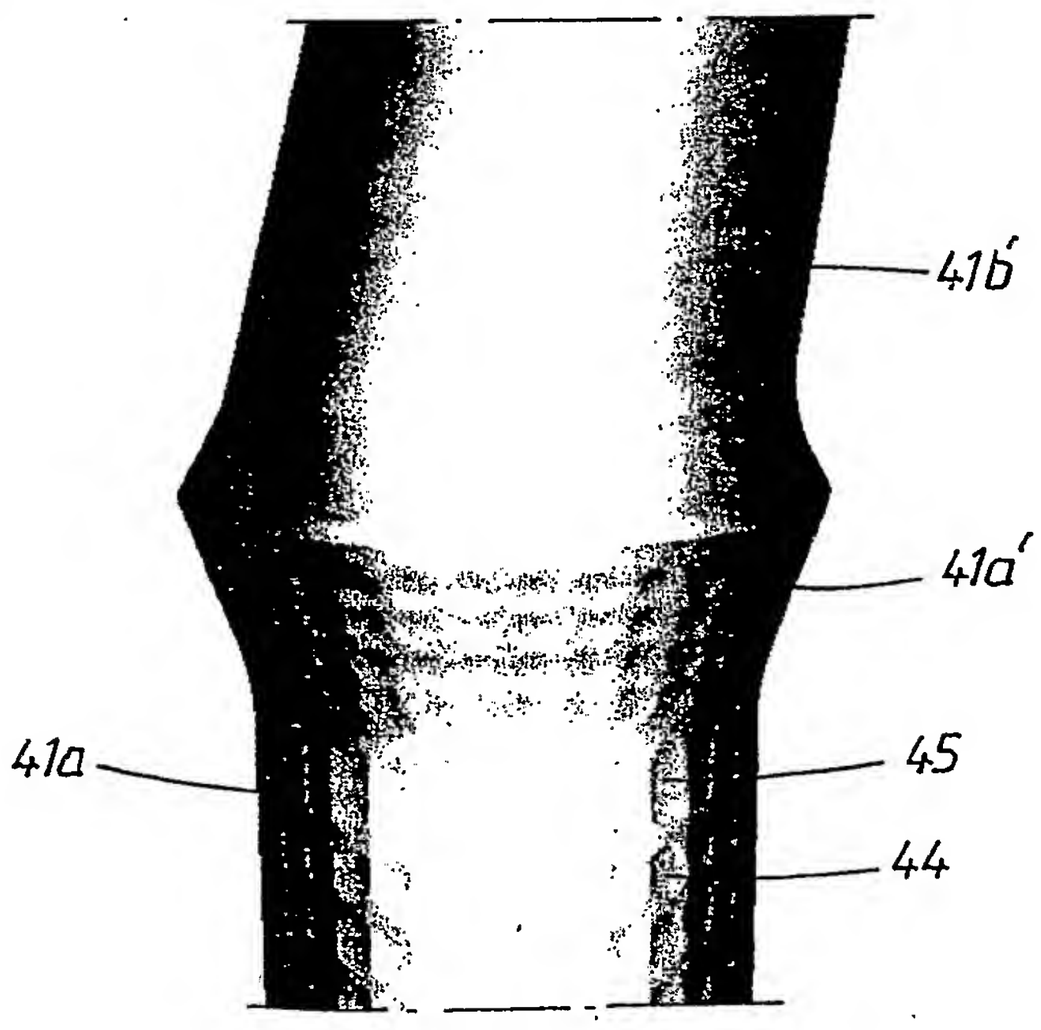
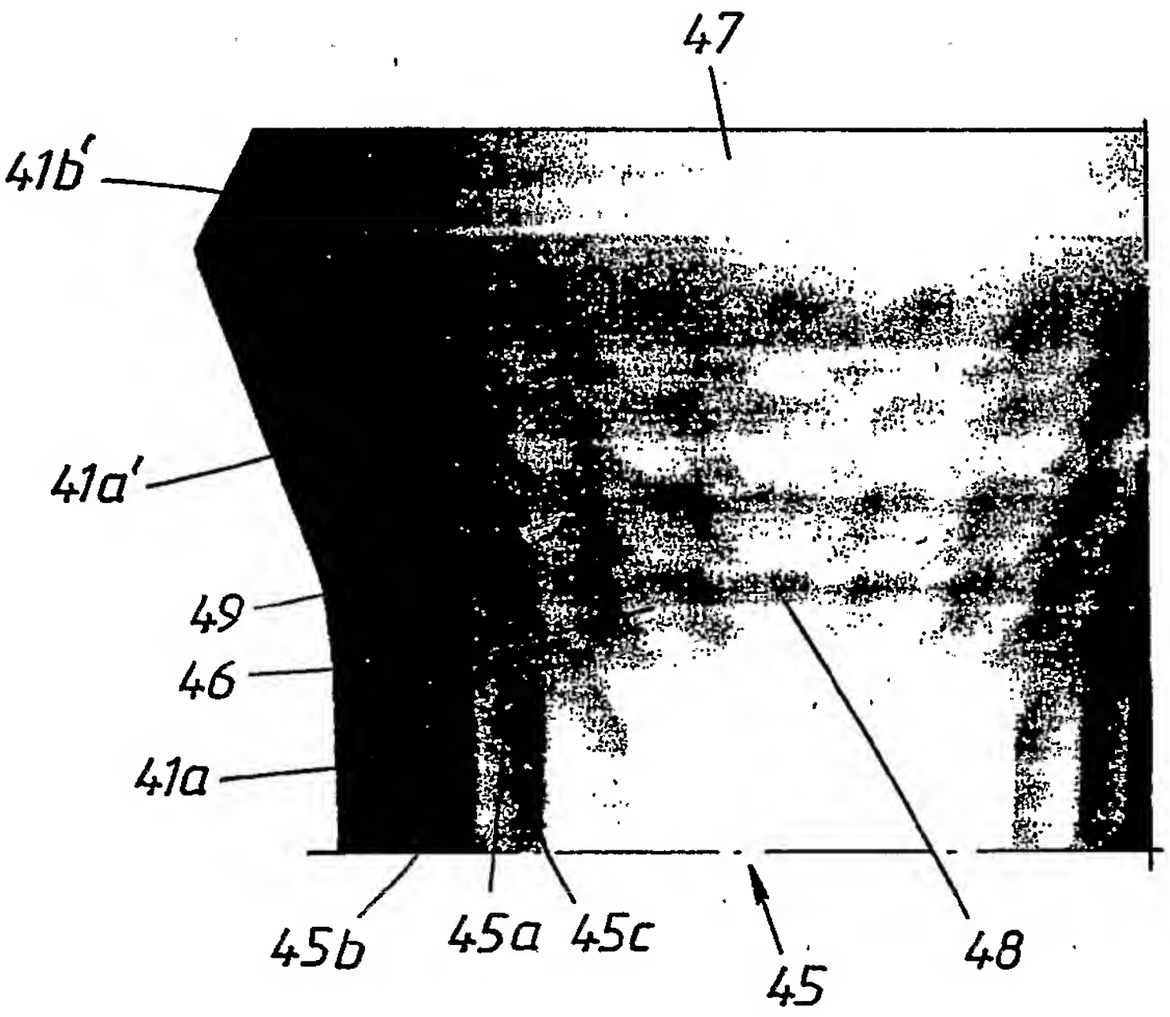


Fig.5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41b'
41a'
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41a
45b
45a
45c
45
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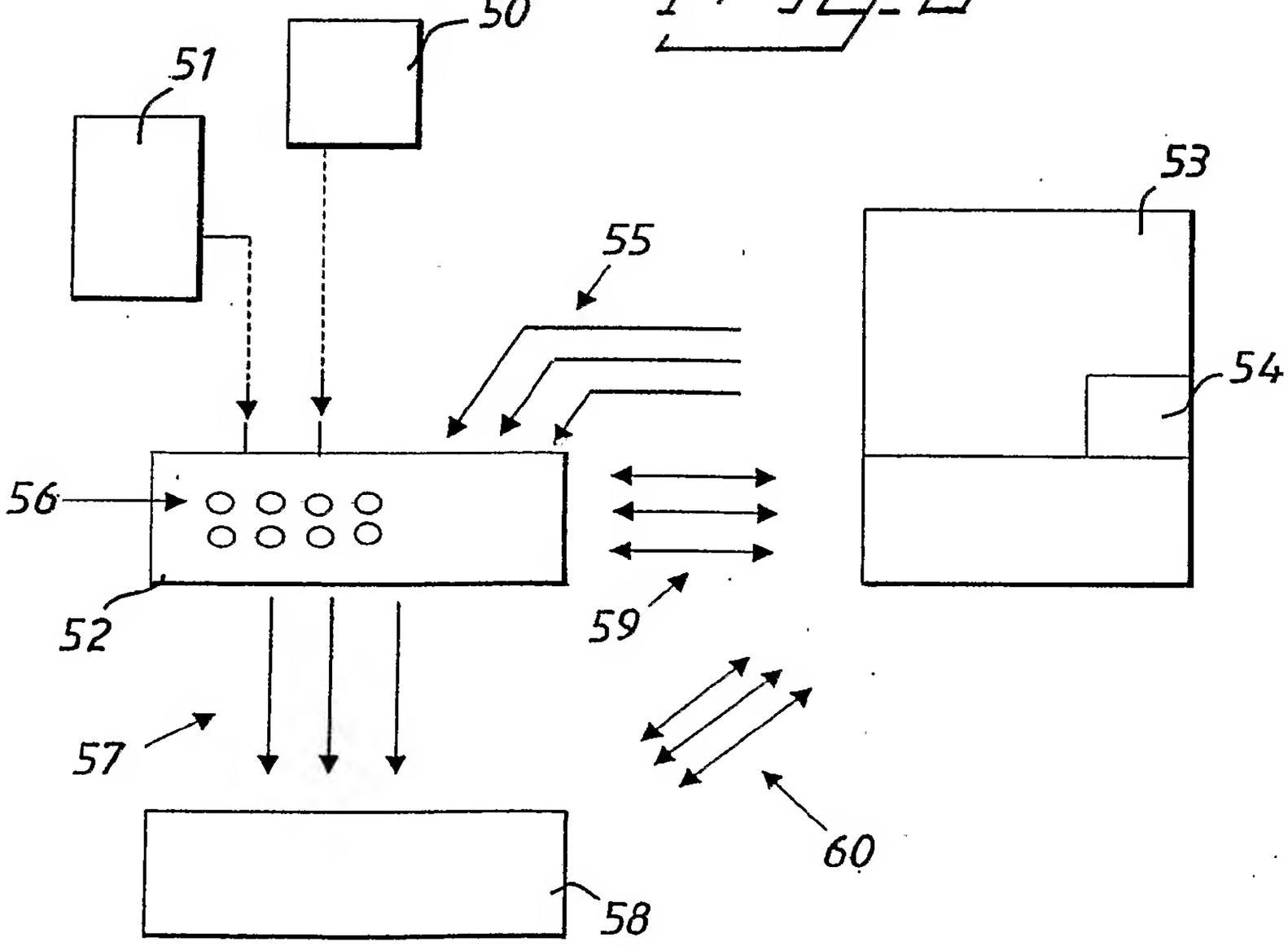
Fig.6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# INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 02/02360

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: A61C 8/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: A61C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
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Information on patent family members

30/12/02

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